Development of aSi/cSi heterojunction strip detector for X-ray/gamma ray imaging

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I. Introduction

Hydrogenated amorphous silicon (a-Si: H) is resistive to radiation and suitable for large area fabrications, Compared with the normal planar process, the a-Si/ c-Si heterojunction technology greatly simplifies the fabrication procedures.

We applied amorphous silicon film techniques in fabricating a-Si/ c-Si heterojunction strip detector. Each strip of the detector has a leakage current of ~10 nA when a bias of 120 V is applied, and it has energy resolutions of 3.0 keV FWHM @ ^{241}Am 59.5 keV peak. We obtained 2-dimensional images of iron and tungsten objects with ^{137}Cs source and edge on silicon strip detector. The strip detector will be applied in X-ray/gamma ray imaging.

II. Strip Detector

A. Silicon strip detector

The silicon strip detector has 500 μm thick crystalline Si wafer and total area of 52.5mm×52.5mm. A detector has 50 strips with 0.5 mm width and 0.5 mm gap between two strips (Fig. 1).

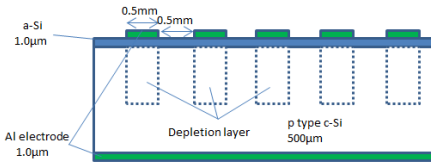

Fig. 1 Cross section of the heterojunction strip detector

B. leakage characteristics

We measured leakage current characteristics of the fabricated detector, and the leakage current of all strips is lower than 12 nA when a bias of 120 V is applied.

C Spectrum measurements

We connected the detector with commercial preamp and amplifier to measure spectra. Instrumentation consists of a Clear pulse 5005H preamp, an Ortec 571 shaping amplifier and an Amptek 8000D MCA.

The measured spectra of ^{241}Am and ^{57}Co are shown in Fig. 2, and 3.0 keV @ 59.5 keV and 3.1 keV @122 keV are obtained.

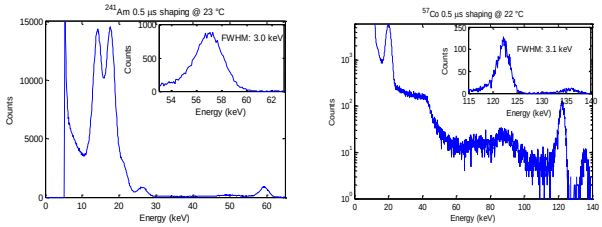

Fig. 2 (a) ^{241}Am spectrum (b) ^{57}Co spectrum

III. 2-D Scan of a Tungsten Object

We stacked two strip detectors (9.6 mm distance) and ASICs and used ^{137}Cs source and scanned the image of an R1.5 cm x 2.0 cm tungsten cylinder with conical hole in the center.

The obtained imaging by 2 detectors is shown in Fig.3. Not only the center hole but also the outer edge of the tungsten cylinder can be clearly seen in the two figures. The imaging would be much clearer if high intensity X-ray is applied.

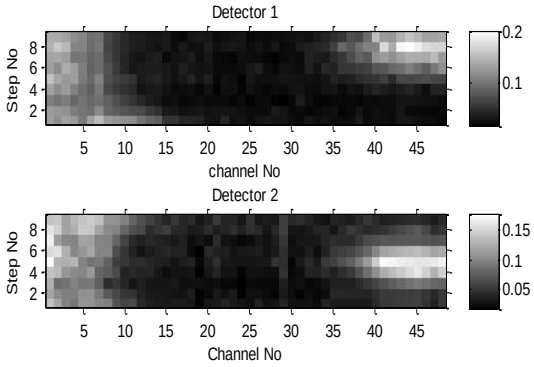

Fig.3 9-step imaging of a tungsten object by 2 detectors

IV. Conclusion and Future Work

We fabricated a novel amorphous Si/ crystalline Si (a-Si/ c-Si) heterojunction strip detector. It has an energy resolution of 3.0 keV FWHM at 59.5 keV. We aligned two edge-on strip detectors with ^{137}Cs source and obtained 2-dimensional images of a tungsten object.

We are now constructing a compact photon-counting imaging system for industrial applications, and the system will be used for inspecting ~1 m thick concrete structures of bridges, roadways, reactor vessels and other infrastructures.